КРУГ

SPC «KRUG»

Automation in oil processing

Technical solutions

About the company

SPC «KRUG» is one of the largest engineering companies in the country in the field of automation, technical and commercial resources accounting for petroleum refining facilities, gas, chemical industry, energy, housing and communal services and other industries.

Over the past 23 years, more than 550 automation systems, mostly for hazardous processes, machinery and plants, were put into operation based on the software and hardware SPC «KRUG».

The company staff comprises more than 100 highly qualified specialists. Branches and offices operate in 4 cities of the country. The SPC «KRUG» quality management system satisfies the requirements of ISO 9001 since 2002. The company operations are validated by more than 30 certificates, licenses and permits, including Rostechregulation of the RF, Rostekhnadzor of the RF, Rosstroy of the RF, as well as State Standards of the Republic of Belarus and the Republic of Kazakhstan.

Main areas of activity

- Production of certified hardware and software systems for building demanding production automation system
- Creating integrated technical and commercial resource accounting systems
- Manufacturing of software for industrial automation
- Oil and petroleum product commercial accounting systems
- Automation systems for oil and gas processing facilities (CDU, APS, AVPS, OTP, UOPU, reforming, gas fractionation unit, LP, furnaces, tank farms, offsites etc.)
- Console designs for creating operator and dispatcher automated workstations
- Training of operational and technological personnel
- Development of integrated plant automation system creation concepts
- Development of design and estimate documentation
- Engineering works
- Commissioning works
- Project management
- Etc.

Our solutions are complex projects that enable increased control efficiency over complex technological processes in the oil processing, gas and chemical industries.

Certificates and licenses

Crude oil processing unit DCS

Control objects

APS (AVPS) units, CDU units, etc. designed for crude oil processing and production of gasoline, kerosene, diesel and fuel oil.

DCS implementation objectives

- Bringing the control system in accordance with the current Rostekhnadzor rules and regulations on fire and explosion safety
- Optimization of technology and reconstruction of control systems
- Increasing the reliability and performance characteristics of equipment
- Improvement of the economic efficiency of the plants via:
  - Improving the quality of the technological processes through better digital regulation and control
  - Reduction of losses from control system failures through the use of more reliable means of monitoring, control and display
  - Reduction of losses from pre-emergency situations and inefficient technological modes
  - Reduction of hardware maintenance costs due to the use of more flexible and sophisticated equipment protection systems
- Improving the efficiency and reducing the complexity of the work of operating personnel.

System functions

Information

- Parameter measurement and control
- Detection, indication and recording of parameters deviating from established boundaries
- Manual data entry
- Generation and output of operational data
- Parameter history backup
- Calculation tasks:
  - Calculation of steam consumption per unit
  - Calculation of fuel oil consumption for furnace combustion
  - Calculation of fuel gas consumption for furnace combustion
  - Calculation of raw material and energy consumption, produced oil products
  - Equipment running time logging
- Lockout and protection activation analysis.

Control

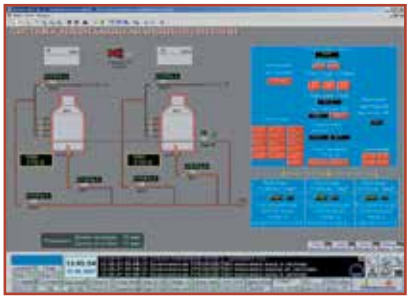
- Emergency Shutdown (ESD) and hardware lockouts
- Issuance of discrete control actions from a functional keyboard to the ADs
- Automatic regulation.

Utility

- Testing and self-diagnostics of the system's hardware and software equipment
- System reconfiguration (software reconfiguration)
- Detailed on-screen help
- Monitoring and recording of operator actions
- Monitoring of information input
- Generation of events protocols, operator's logs
- Archiving of trends, printed documents, protocols
- Generation and storage of secure print documents, pre- and post-emergency situation protocols
- System time correction.

Automatic emergency liquidation subsystem (fire, release of light hydrocarbons, etc.)

- Emergency liquidation time reduced to a few seconds
- Erroneous actions when liquidating emergencies are eliminated
- Risk of personnel injury during emergency liquidation operations is minimized.



The solution is implemented at the **«RN-Tuapse Refinery» OOO AT-1,2,3 plant («Rosneft» OAO) etc.**

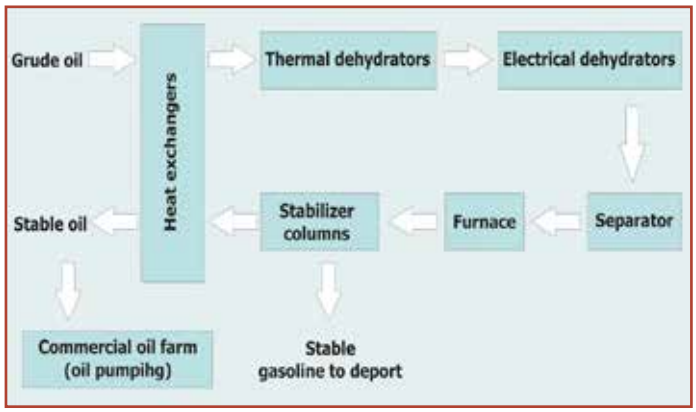
Unified oil processing unit DCS

Control object

Unified oil processing and stabilization unit with light hydrocarbon fraction removal.

DCS implementation objectives

Increasing the efficiency and reliability of equipment, improving system performance, increasing productivity and improving the working conditions of the operating personnel, bringing the control system in accordance with the current rules and regulations on fire and explosion safety.

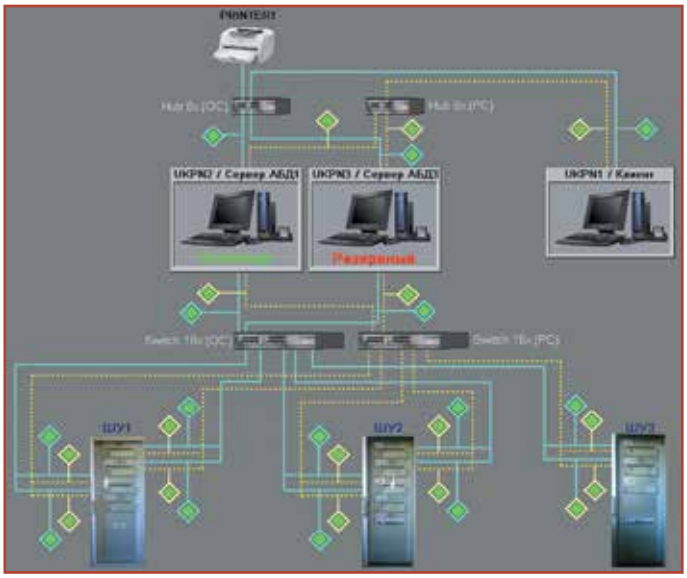


System functions

- Parameter monitoring and indication
- Digital regulation
- Providing information to operators, DCS services, instrumentation and automation
- Process logging: event logs, operator's logs
- Self-diagnostic of hardware and software elements
- Archiving of trends, printed documents, operator's logs, protocols.

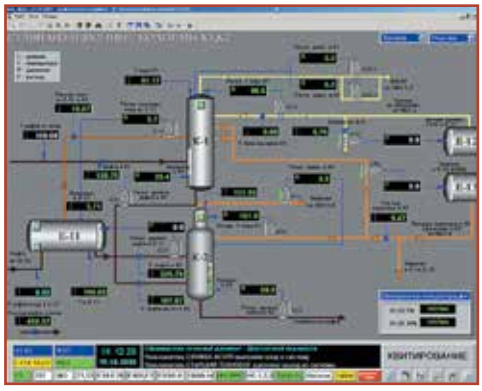
Components

- Microprocessor controllers (100% hot standby of the processor part)
- Installation cabinets
- KRUG-2000® SCADA
- Operator consoles based on the ConsErgo® generic universal designs
- Database server with backup and hot standby features, combined process operator workstations
- Process operator workstations (clients)
- Network equipment - ETHERNET 10/100 Mb (100% redundancy)
- Group IS barriers
- Network laser printer.



Results

Implementation of DCS allowed to organize stable and accurate measurement and control, the ability to create complex and robust algorithms that combine continuous and consistent control, provide the operational staff with complete, objective, accurate and timely information about the operations of the installation.



This solution is implemented at the following sites:

- **NGDU «Aznakaevskneft» unified oil processing unit, Aznakaevo («Tatneft» OAO)**
- **Oil and gas production unit in Neftekumsk («NK» Rosneft-Stavropolneftegaz» OAO).**

Reforming unit DCS

Control objects

Reforming units designed to produce gasoline, NC-85 fraction by-products and liquefied hydrocarbon gas.

DCS implementation objectives

- Gradual replacement of outdated instrumentation and automation boards
- Increasing the accuracy of maintaining a process mode
- Bringing the control system in accordance with the current rules and regulations on fire and explosion safety
- Increase the reliability of the equipment and improving the quality of oil products.

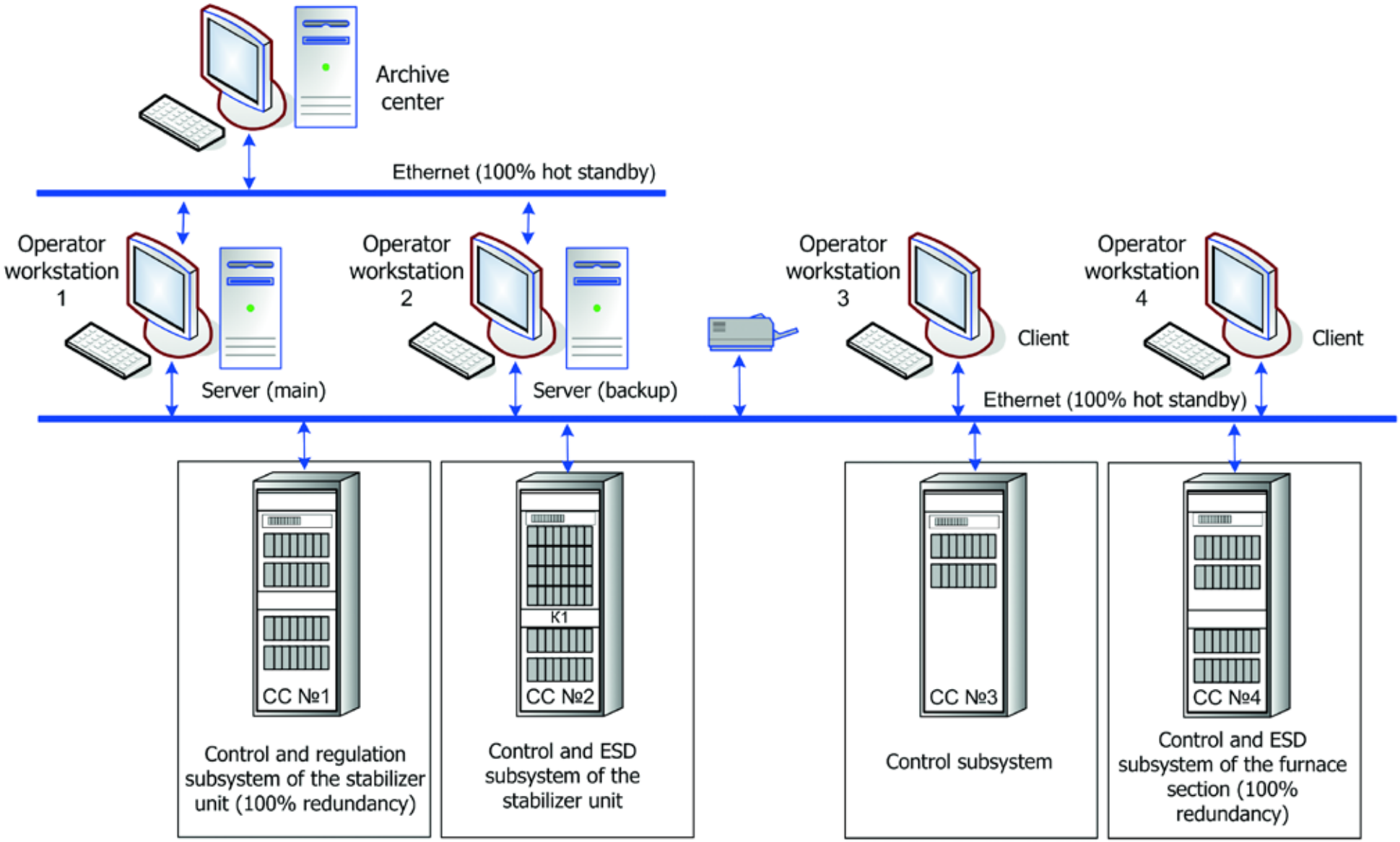
System functions

- Collection, display and recording of process parameters
- Automatic and remote control (regulation) of analog and digital actuator devices (AD)
- Implementation of Emergency Shutdown (ESD), incl.:
  - Pump protection from high pump and electric motor bearing temperatures, low pressure in the supply line (pump «reset»)
  - Furnace lockout from high temperatures at the exhaust gas dam, product outlet, etc.
  - Protection from furnace lockout on a false signal from the sensor
  - Unauthorized furnace ignition protection
- Automatic condensate evacuation by pump from flare tank level
- Automatic activation of a backup supply fan from low pressure in the operator room
- Automatic activation of furnace and pumping room steam curtain from gas content in the area
- Calculations:
  - Calculating product yield and raw material costs
  - Calculating the amount of heat including with installation input and exhaust condensate
  - Calculation of fuel gas balance
  - Pump and fan running time logging
  - Etc.
- Process logging: event logs, operator's logs, protocols, pre- and post-emergency situation protocol
- Archiving of trends, printed documents, protocols.

Components

- Microprocessor controllers (including Ex variants)
- KRUG-2000® SCADA, including development (database generator, graphical editor, process programming language, etc.) and runtime environments (operator workstation executable modules)
- The engineering station software is an DCS service operator automated workstation
- The controller real-time operating system (RTOS). The RTOS allows you to create all sorts of hot standby schemes: 100% redundant controllers, redundant controller processor parts, I/O cards, individual I/O channels.
- PC-based operator workstations (including industrial designs), equipped with process keyboards
- Local control network - Fast Ethernet (100 Mb/s), Gigabit Ethernet (1 Gb/s)
- Installation cabinets based on designs for controller installation
- Operator consoles based on the ConsErgo® generic universal designs.

The solution is implemented at the **«RN-Tuapse Refinery» L-35-11/300 reformer unit («Rosneft» OAO) and others.**


Archive center
Ethernet (100% hot standby)
Operator workstation 1
Server (main)
Operator workstation 2
Server (backup)
Operator workstation 3
Client
Operator workstation 4
Client
Ethernet (100% hot standby)
CC №1
Control and regulation subsystem of the stabilizer unit (100% redundancy)
K1
CC №2
Control and ESD subsystem of the stabilizer unit
CC №3
Control subsystem
CC №4
Control and ESD subsystem of the furnace section (100% redundancy)

In-flow fuel mixing DCS

Control objects

Diesel fuel additive injection unit to the light oil mixing park (FMP). In addition to the said unit, the FMP includes several tank farms, gasoline mixing units and a diesel fuel mixing unit.

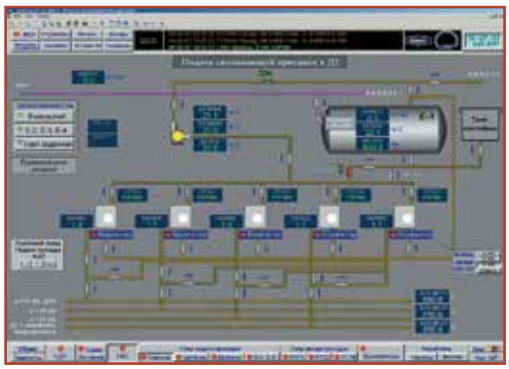
The DCS implementation is characterized by the inability to stop the process equipment, even for a relatively short time. Based on the accumulated experience, such works are carried out by experts on operating equipment.

DCS implementation objectives

- Receiving the highest quality fuels
- Introduction of the diesel fuel additive injection unit control system as part of a unified control system
- Ensuring high reliability and fault tolerance of the control and monitoring system
- Establishing communication with the plant's CAM system
- Improving the working conditions of installation staff.

System Functions

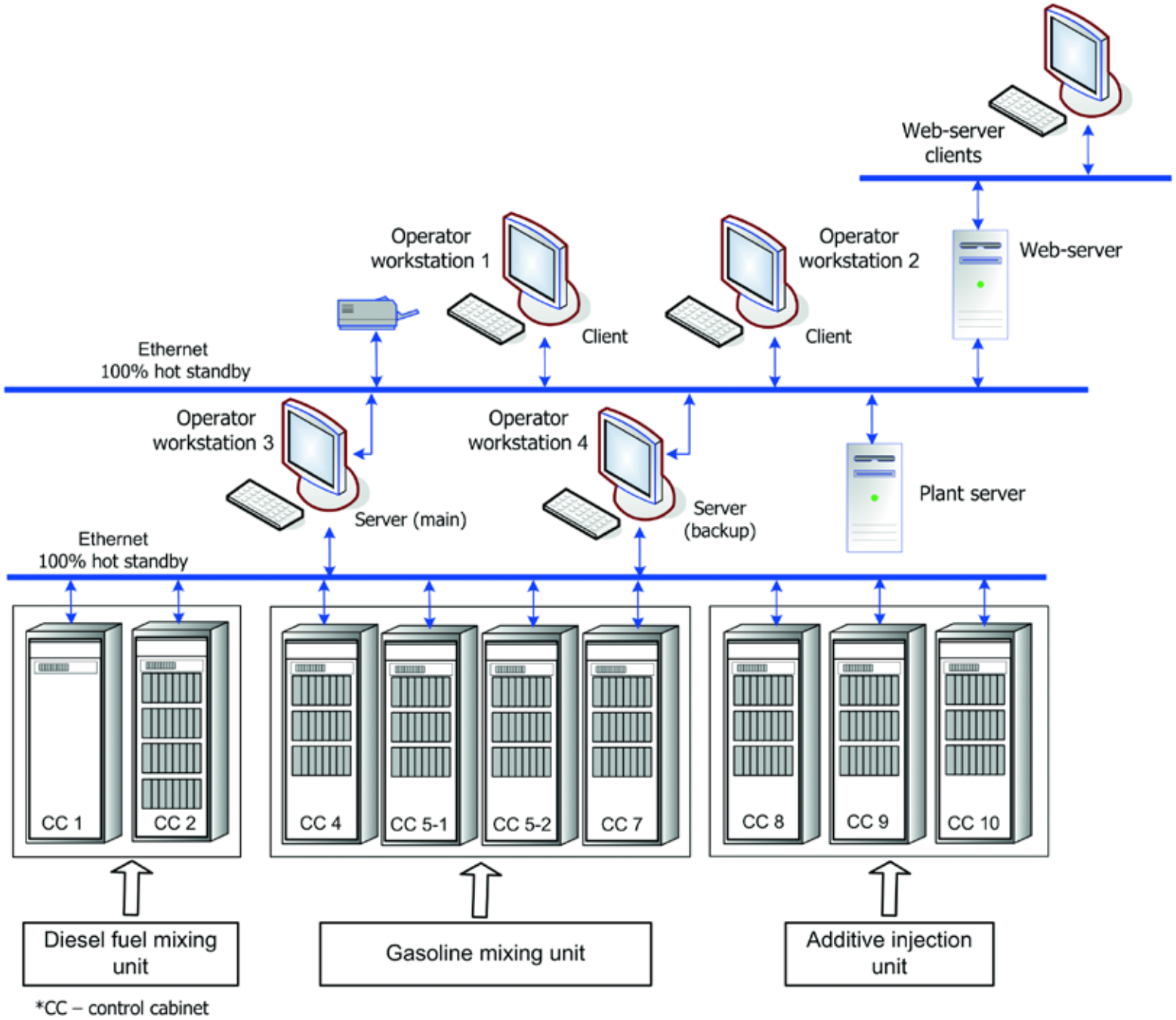
- Parametric mapping of the status of certain areas of the site
- Screen and sound indication of parameters crossing the technological and emergency limits, emergency situation indication
- Automatic actuator and drive control
- Remote regulator control
- Emergency Shutdown and lockout subsystem (ESD)
- Redundancy and diagnostics of local computer networks used for connecting with servers
- Correction of own system time when a command is received from the database servers
- Control system functionality access management via passwords
- System message log viewing:
  - Errors and other events at the site and in the control system
  - Operator actions
  - Operation of the monitoring and control equipment complex
- Viewing the history of process parameters on the screen in the form of graphs and tables, and as a printout in tabular form or as a copy of the screen
- Viewing of paper document archives on the screen and as a printout.



Components

- Microprocessor controllers (100% hot standby of the processor part)
- Database server with backup and hot standby features, combined process operator workstations
- Process operator workstations (clients)
- Web-server
- Plant communication server
- Network printer
- KRUG-2000® SCADA
- Controller real-time operating system (RTOS)
- Console designs based on the ConsErgo® generic universal designs.

The solution is implemented at the following sites: **«Kirishinefteorgsintez» FMP-1 unit, tank farms, gasoline mixing units and a diesel fuel mixing unit..**


Web-server clients
Operator workstation 1
Client
Operator workstation 2
Client
Web-server
Ethernet 100% hot standby
Operator workstation 3
Server (main)
Operator workstation 4
Server (backup)
Plant server
Ethernet 100% hot standby
CC 1
CC 2
CC 4
CC 5-1
CC 5-2
CC 7
CC 8
CC 9
CC 10
Diesel fuel mixing unit
Gasoline mixing unit
Additive injection unit
*CC – control cabinet

Mini-refinery DCS

Control object

Mini-refinery for crude oil refining and producing high-octane gasoline, diesel fuel, fuel oil. Control object belongs to the second explosion hazard category.

DCS implementation objectives

- Creating a control system in accordance with the current rules and regulations on fire and explosion safety
- Ensuring accident-free operation of equipment
- Improving the quality and reducing the complexity of the work of operating personnel.

Components

- Microprocessor Controllers
- PC-based operator workstations
- KRUG-2000® SCADA
- Network equipment - ETHERNET 10/100 Mb (100% redundancy)
- Network laser printer
- Enclosures - 19 ‘’ cabinets (RITTAL) and ConsErgo® operator consoles
- Uninterruptible Power System
- External circuits power supply.

System functions

Information functions

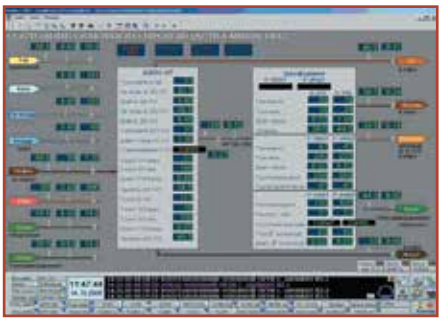
- Parameter measurement and control
- Detection, indication and recording of parameters deviating from established boundaries
- Manual data entry
- Generation and output of operational data
- Parameter history backup
- Calculation tasks:
  - Calculation of steam consumption per unit
  - Calculation of fuel oil consumption for furnace combustion
  - Calculation of fuel gas consumption for furnace combustion
  - Calculation of raw material and energy consumption, produced oil products
  - Equipment running time logging
- Lockout and protection activation analysis
- Formation of protocols of events, the regime sheets
- Archiving of trends, printed documents, protocols
- Generation and storage of secure printed documents
- Monitoring of information input
- System time correction.

Control functions

- Emergency Shutdown (ESD) implementation
  - Automatic condensate evacuation by pump from flare tank and level
  - Pump protection
  - Furnace lockout
  - Automatic activation of furnace and pumping room steam curtain
  - Protection of the reactor block
  - Protection from unauthorized AD control
  - Emergency shutdown of CDU-APS and zeoforming units
  - Equipment running time tracking
  - Generation and printing of reporting documents
  - Monitoring and registration of protection actions
- Issuance of discrete control actions from a functional keyboard
- Automatic parameter control.

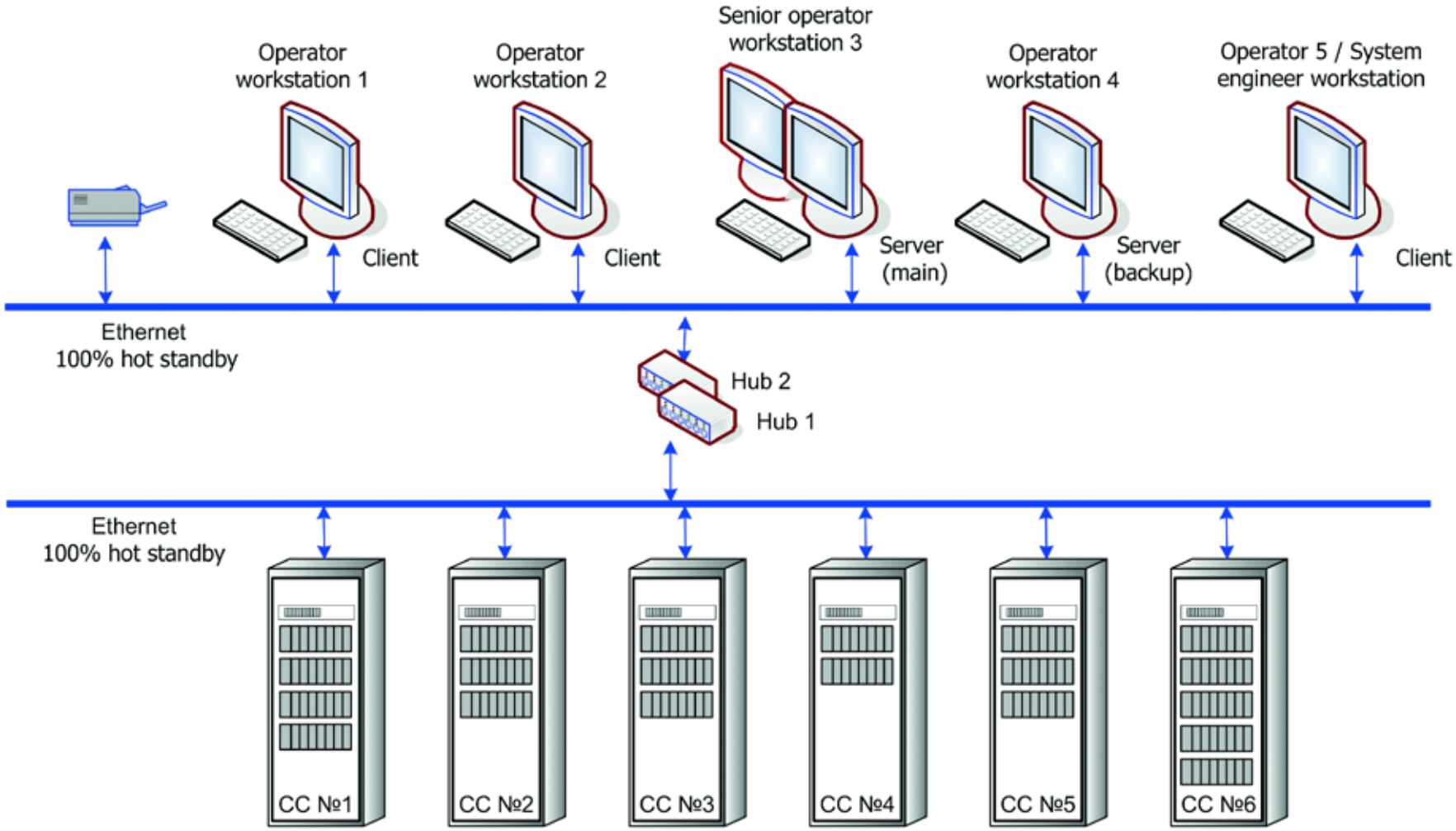
Utility functions

- Testing and self-diagnostics of the system’s hardware and software equipment
- System reconfiguration (software reconfiguration)
- Detailed on-screen help
- Monitoring and recording of operator actions.



The system includes an emergency response training system built into the DCS for the periodic training of operating personnel.

The solution is implemented at a mini-refinery in **Kochenevo, Novosibirsk Region («VPK-Oil» OOO).**


Operator
workstation 1
Operator
workstation 2
Senior operator
workstation 3
Operator
workstation 4
Operator 5 / System
engineer workstation
Client
Client
Server
(main)
Server
(backup)
Client
Ethernet
100% hot standby
Hub 2
Hub 1
Ethernet
100% hot standby
CC №1
CC №2
CC №3
CC №4
CC №5
CC №6

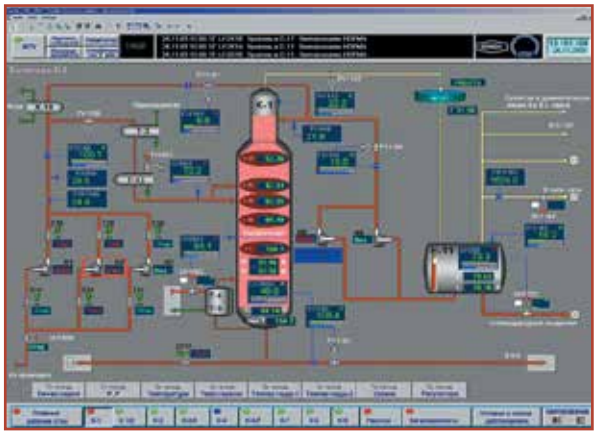
Gas fractionation plant DCS

Control object

Gas fractionation plant for processing gas gasoline coming from the installations of oil refining and production of propane, butane, isobutane, and others. The unit consists of feedstock tank farms, raw material purification unit from hydrogen sulfide, block compression, power rectification, and other auxiliary systems.

DCS implementation objectives

- Bringing the technological process of oil product processing in accordance with the current rules and regulations
- Ensuring high reliability and fault tolerance of the control and monitoring system
- Establishing communication with the plant's CAM system
- Improving the working conditions of installation service staff.



System functions

The DCS is a full-scale control system and includes an information subsystem, an emergency shutdown and lockout (ESD) subsystem, automatic regulation and remote control subsystems, data collection, visualization and archiving subsystems, etc. In addition to these subsystems, the DCS provides control signals to the fire-fighting and ventilation systems.

System architecture

The DCS is a three-level distributed control system using a client-server architecture.

The 1st (lower) level of the system includes: microprocessor controllers of the ESD subsystem, automatic regulation, remote control and information subsystem. Data is exchanged using an optical communication line. Microprocessor controllers used in the ESD and automatic regulation subsystems are made with 100% hot standby. The information subsystem controllers feature CPU module hot standby. A feature of this subsystem is the exchange of data via the RS-485 interface with an MTL8000 controller.

The 2nd (middle) level of the system includes two database (DB) servers - 100% hot standby. The database servers are designed for the collection and processing of the operational data from controllers and other system users, storage and display of archive information, and its provision to the top level users (operator stations) in client-server mode. Information exchange uses a Fast Ethernet LAN (100% hot standby).

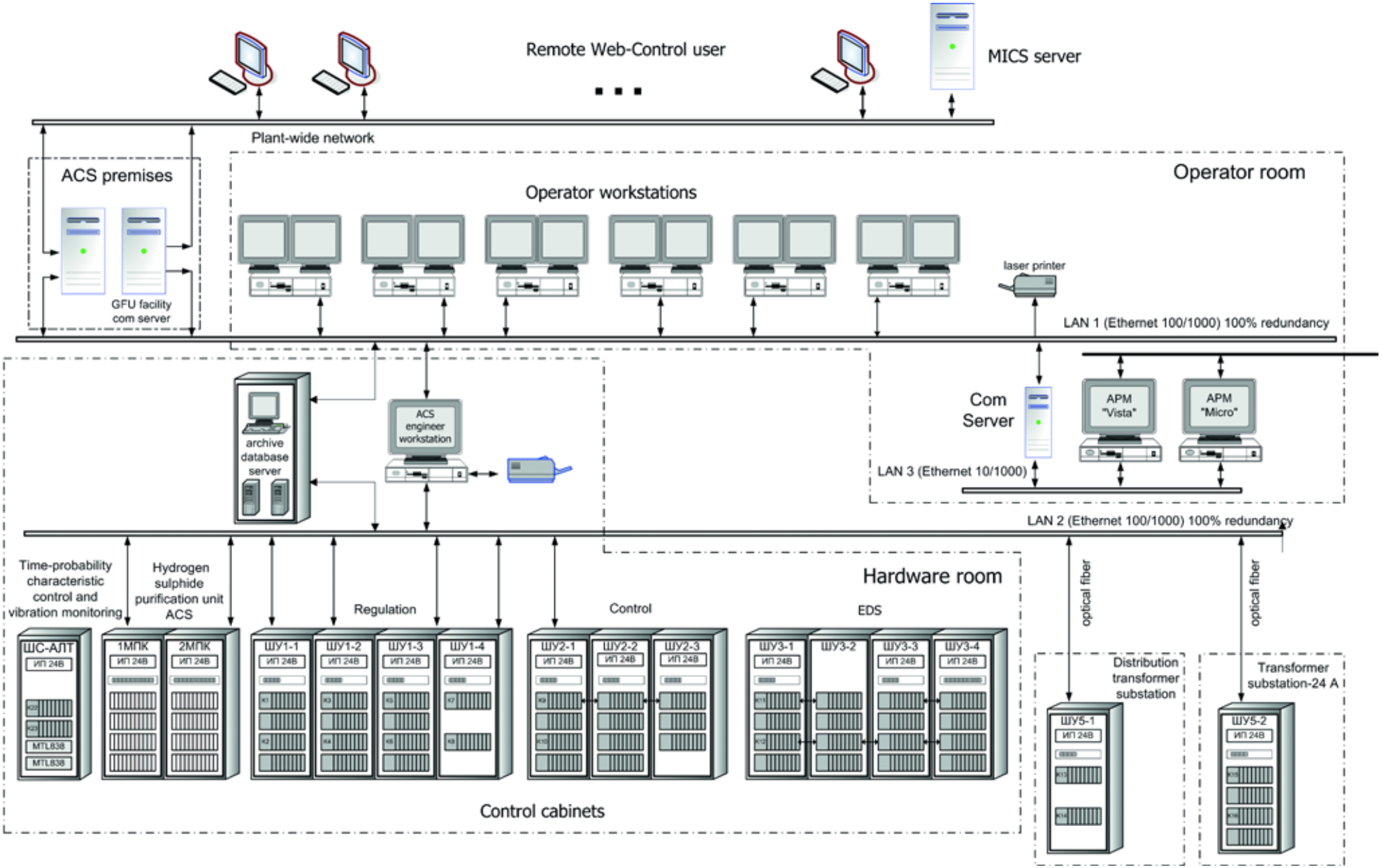
In the 3rd (top) level of the system includes: operators automated workstations, DCS engineer station, Web-server, communication server, plant communication server, printing equipment.

Contact between the upper and middle levels of the DCS is implemented through a Gigabit Ethernet LAN (100% hot standby) technology.

Software

- KRUG-2000® SCADA
- Controller real-time operating system (RTOS).

The solution is installed at the **PO «Kirishinefteorgsintez» gas fractionation unit.**


Remote Web-Control user
MICS server
Plant-wide network
ACS premises
GFU facility com server
Operator room
Operator workstations
laser printer
LAN 1 (Ethernet 100/1000) 100% redundancy
archive database server
ACS engineer workstation
Com Server
APM "Vista"
APM "Micro"
LAN 3 (Ethernet 10/1000)
LAN 2 (Ethernet 100/1000) 100% redundancy
Hardware room
Time-probability characteristic control and vibration monitoring
Hydrogen sulphide purification unit ACS
Regulation
Control
EDS
optical fiber
optical fiber
ШС-АЛТ
1МПК
2МПК
ШУ1-1
ШУ1-2
ШУ1-3
ШУ1-4
ШУ2-1
ШУ2-2
ШУ2-3
ШУ3-1
ШУ3-2
ШУ3-3
ШУ3-4
ИП 24В
MTL838
Distribution transformer substation
Transformer substation-24 A
ШУ5-1
ШУ5-2
Control cabinets

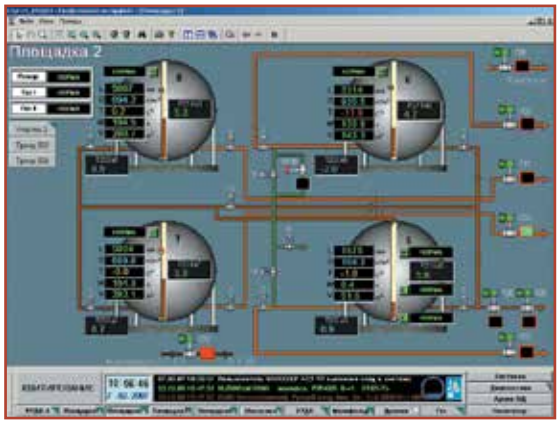
Tank farm DCS

Control objects

Feedstock tank farms of oil refineries etc.

DCS implementation objectives

- Bringing the control system in accordance with the current Rostekhnadzor rules and regulations on fire and explosion safety
- Improving the efficiency and reliability of equipment
- Increasing the performance characteristics of equipment
- Increasing productivity and improving the working conditions of the operating personnel
- Building a system with the possibility of further development and information capacity enhancement in mind.

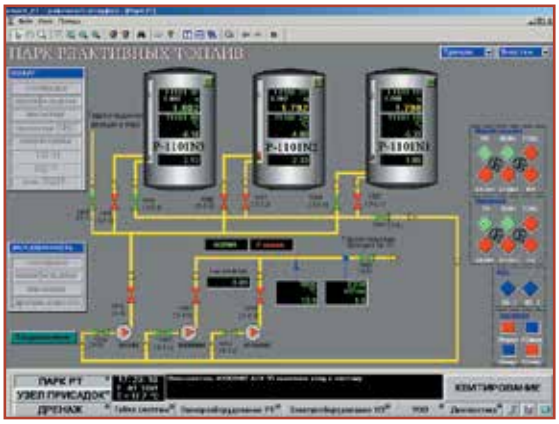


Main system functions

- Parameter monitoring and indication
- Digital regulation
- ESD
- Providing information to process operators, DCS and instrumentation and automation services
- Process logging: event logs, operator's logs
- Calculations: pump and fan running time recording, etc.
- Self-diagnostics of the hardware and software elements
- Archiving of trends, printed documents, protocols.

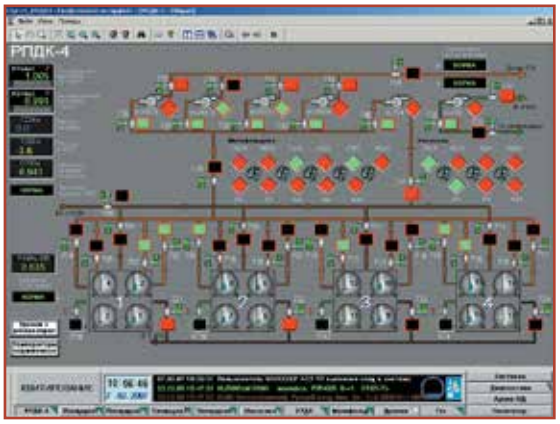
Software

KRUG-2000® SCADA, including development (database generator, graphical editor, process programming language, etc.) and runtime environments (operator workstation/ server and controller archiving executable modules).



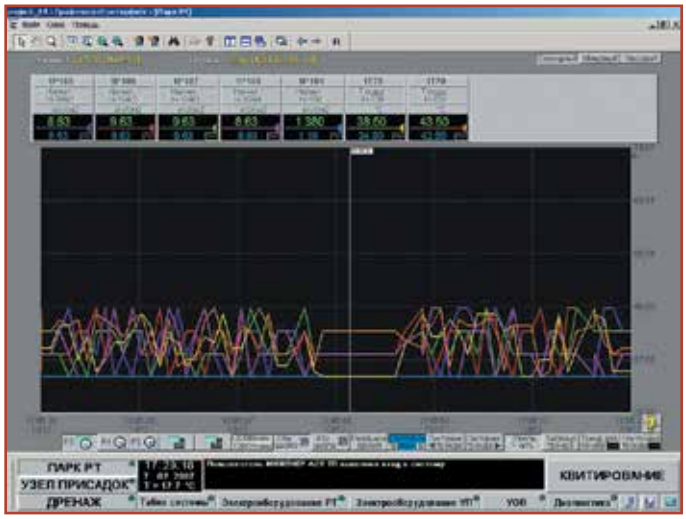
Components

- The controllers are built with 100% hot standby of the processor part
- Digital level gauges, connected to the controller using the RS-485 interface
- Installation cabinets
- Console designs based on the ConsErgo® generic universal designs
- Process operator workstations, server-based (2 pcs). The two servers are working in 100% hot standby mode, and perform real-time system and archiving functions.
- Local Ethernet control network (100% redundancy)
- Laser printer.

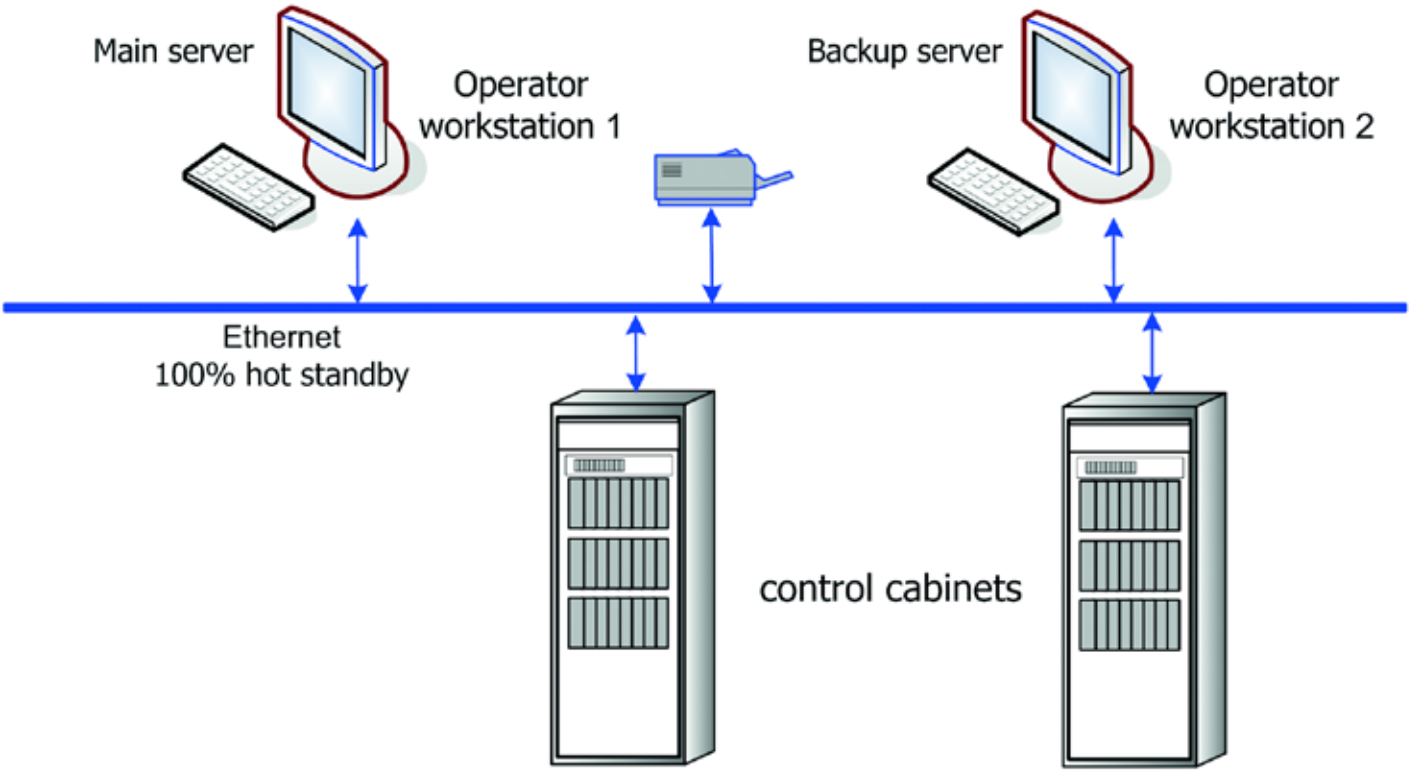


Results

Introduction of the DCS enables the operational staff to receive more comprehensive, objective, accurate and timely information about the operation of the installation. A deep level of self-testing, complete with a number of software and hardware solutions, allow the implementation of complex control and monitoring algorithms. Important benefits include integration of digital level gauges (e.g., Enraf CIU858) into the system, with the ability to service them directly from the operator station.



The solution is implemented at the **«RN-Tuapse Refinery» OOO feedstock tank farm.**



Intelligent system for emergency protection of multi-flow furnaces

Furnace characteristic

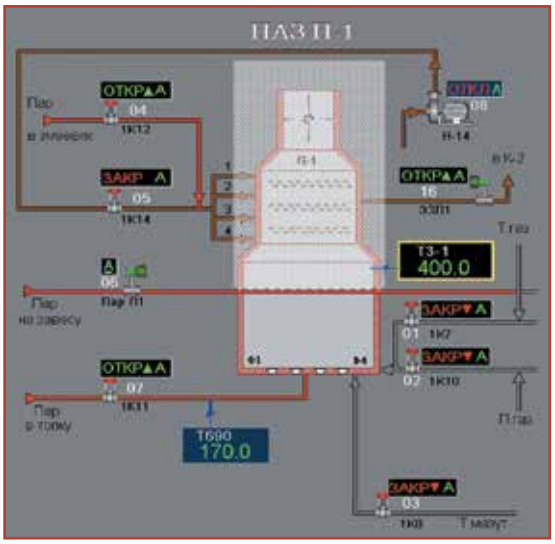
Vertical type, 4 fire chambers, raw material supply from one pump, four main burners and four pilot burners, pilot burner is installed in the throat of the main burner.

The furnace ESD is implemented for the following parameters:

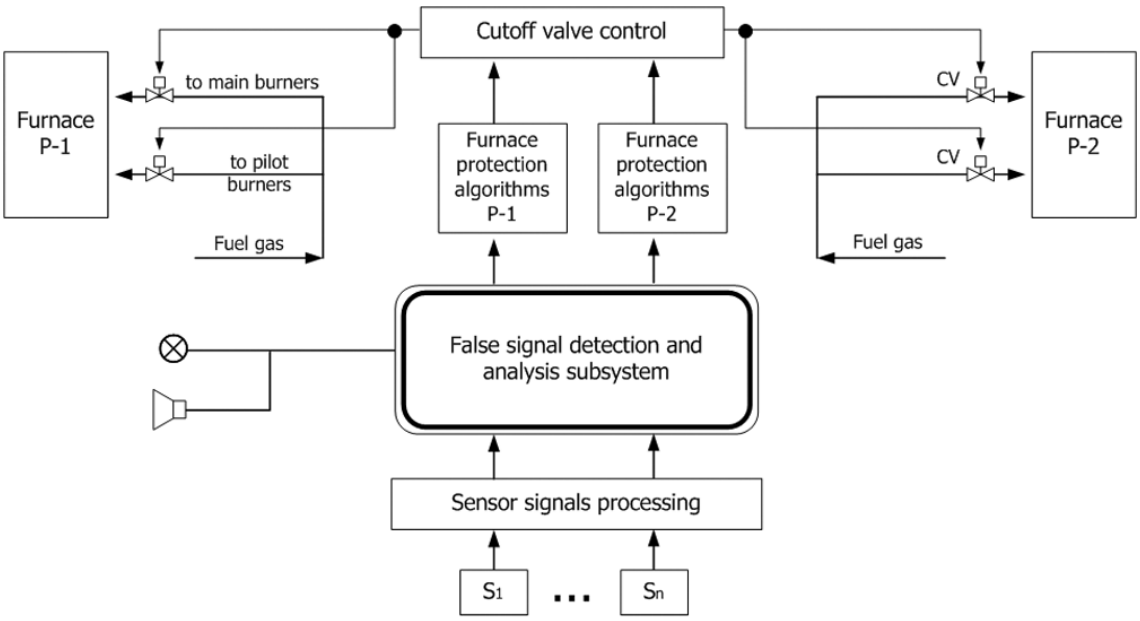
- Cessation of raw material supply in any of the furnace coils
- Exceeding the maximum allowable temperature of the raw material at the outlet of any coil
- Exceeding the maximum allowable temperature at the furnace dam
- Decrease of furnace draft
- Decrease of fuel gas pressure to the pilot burners
- Increase or decrease of fuel gas pressure to the main burners
- Flameout.

Results

- Compliance with the requirements of existing regulations
- Prevention of ESD triggering on a false signal from the sensor
- Protection against unauthorized furnace ignition
  - The operating personnel now has some time for immediate intervention.



The system has passed the Rostekhnadzor industrial safety inspection and operates on the **APS-1 and APS-2 units and the L-35-11/300 catalytic reformer unit at «RN-Tuapse Refinery» OOO.**



Advances furnace protection system scheme
(S – sensor, CV – cutoff valve)

Crude oil distillation process early diagnostic subsystem

DCS implementation objectives

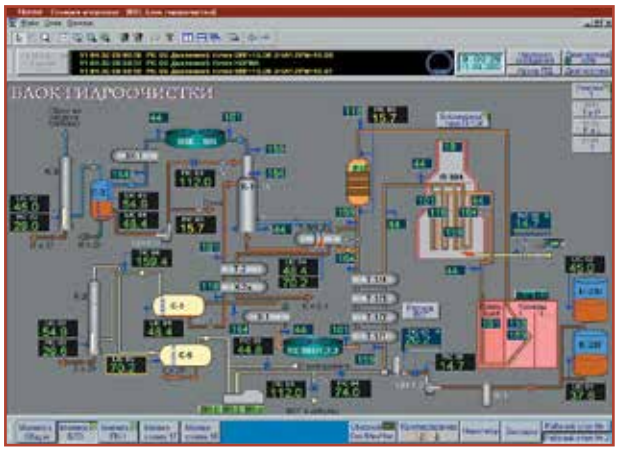
Increasing the stability of maintaining a technological mode

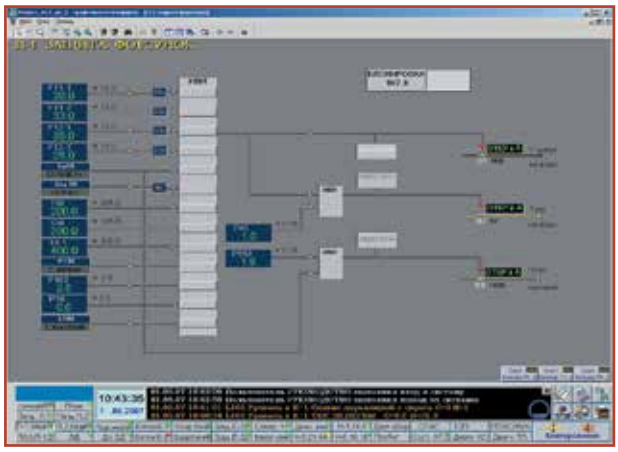
Tasks

- Calculation of the drawoff of light oil products from oil
- Calculation of the column top temperature and the temperature of kerosene drawoff depending on the pressure in the column
- Calculation of the predicted average gasoline boiling temperature, start and end kerosene boiling temperature under the current mode in the column
- Calculation of cold reflux flow to the K-2 column
- Calculation of kerosene circulating reflux flow
- Calculation of steam flow to the kerosene and diesel strippers.

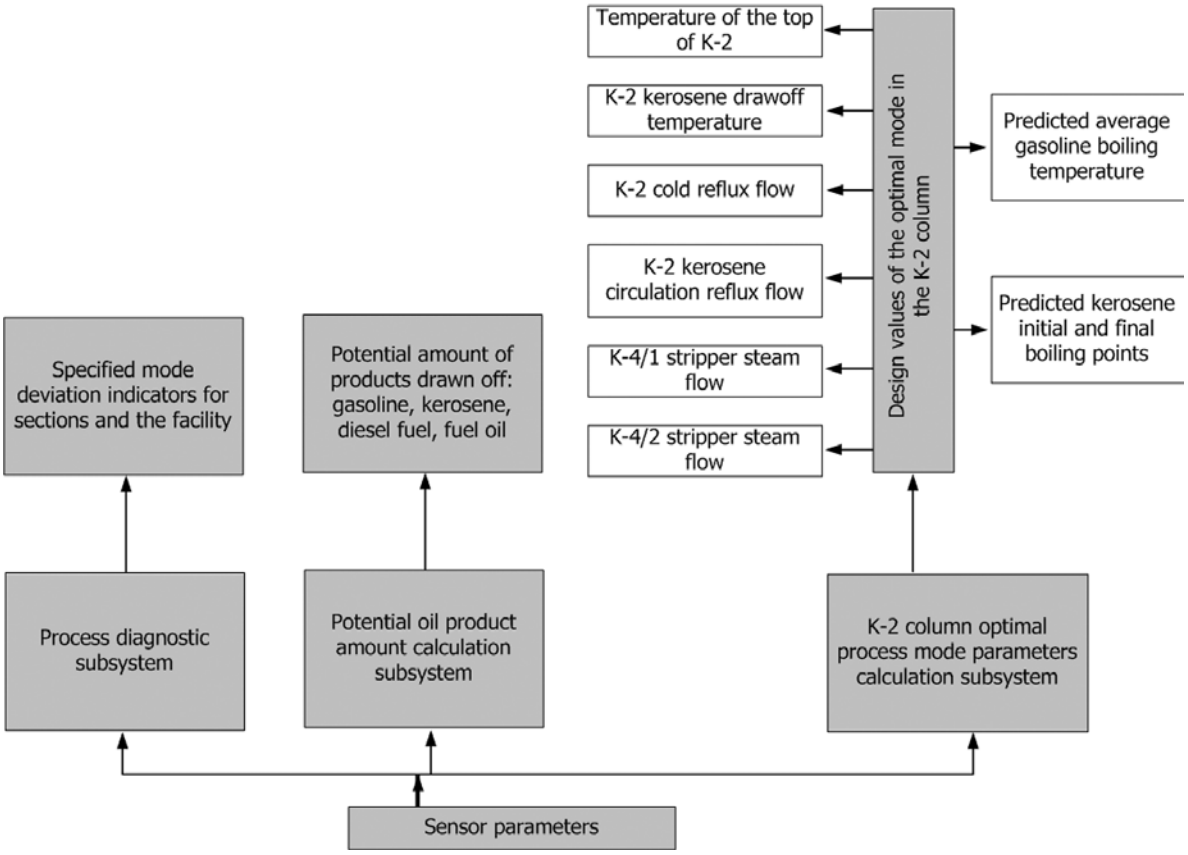
Results

- Identification of deviations of the current mode from the specified one at an early stage
- Calculation of the generalized indicator of the deviation of the current mode from the specified one for each process area and the installation as a whole
- There is no need to analyze a large number of parameters - attention is paid only to parameters whose change led to the mode deviation.





The subsystem operates on the **APS-1 and reforming units at «RN-Tuapse Refinery» OOO.**



Gasoline and kerosene quality prediction subsystem, calculation of mode parameters of the K-2 column on crude oil distillation installations

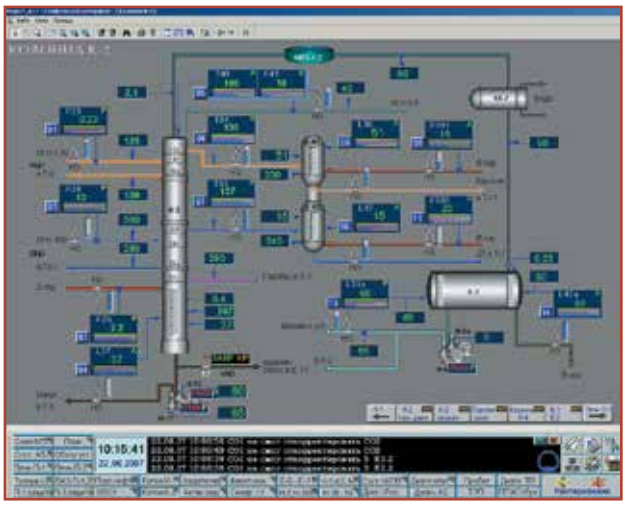
DCS implementation objectives

Increasing the quality of oil products, increased efficiency and reliability of equipment, improvement of equipment performance characteristics.

The quality prediction subsystem for gasoline and kerosene drawn off from the K-2 column on the crude oil distillation installation, in accordance with the current mode in the column, calculates the projected average boiling point of gasoline, the IBP (initial boiling point) and FBP (final boiling point) temperatures of the kerosene fraction.

The mode parameters of the K-2 column, maintaining which should ensure the required quality of gasoline and kerosene, are also calculated:

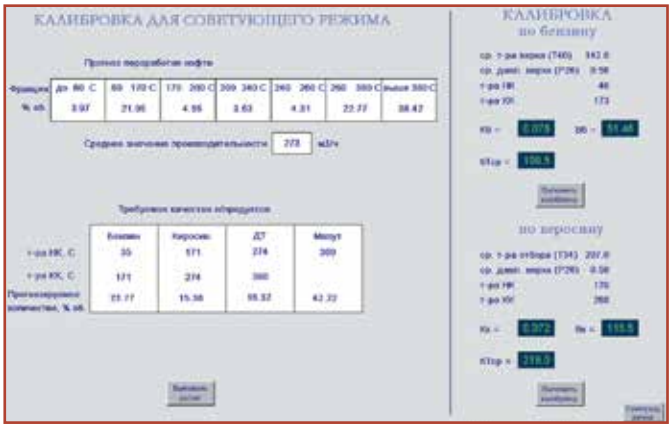
- Temperature of the top of the K-2
- Drawoff temperature of the kerosene fraction column
- Gasoline cold reflux flow
- Kerosene circulating reflux flow



- Steam flow to the kerosene stripper
- Oil drawoff amounts depending on the composition of oil, the quality of the output products and installation performance.

The quality forecasting subsystem allows to:

- Make the flow of the rectification process in the K-2 column more clear and «transparent» for the process staff
- Promptly inform process personnel on necessary actions in the K-2 column process mode management
- Stabilize the fluctuation of gasoline FBP temperature in the range of 2-3 °C
- Reduce the «overlap» of the gasoline and kerosene fraction boiling temperatures to no more than 5 °C.



The subsystem operates on the **APS-1 unit of «RN-Tuapse Refinery» OOO.**

The use of frequency converters in control systems

DCS implementation objectives

Electricity saving.

One of the most important tasks in managing an oil refinery is to reduce costs, namely, the process part of processing costs.

One way to accomplish this is extensive use of frequency converters.

Frequency converters are used to control:

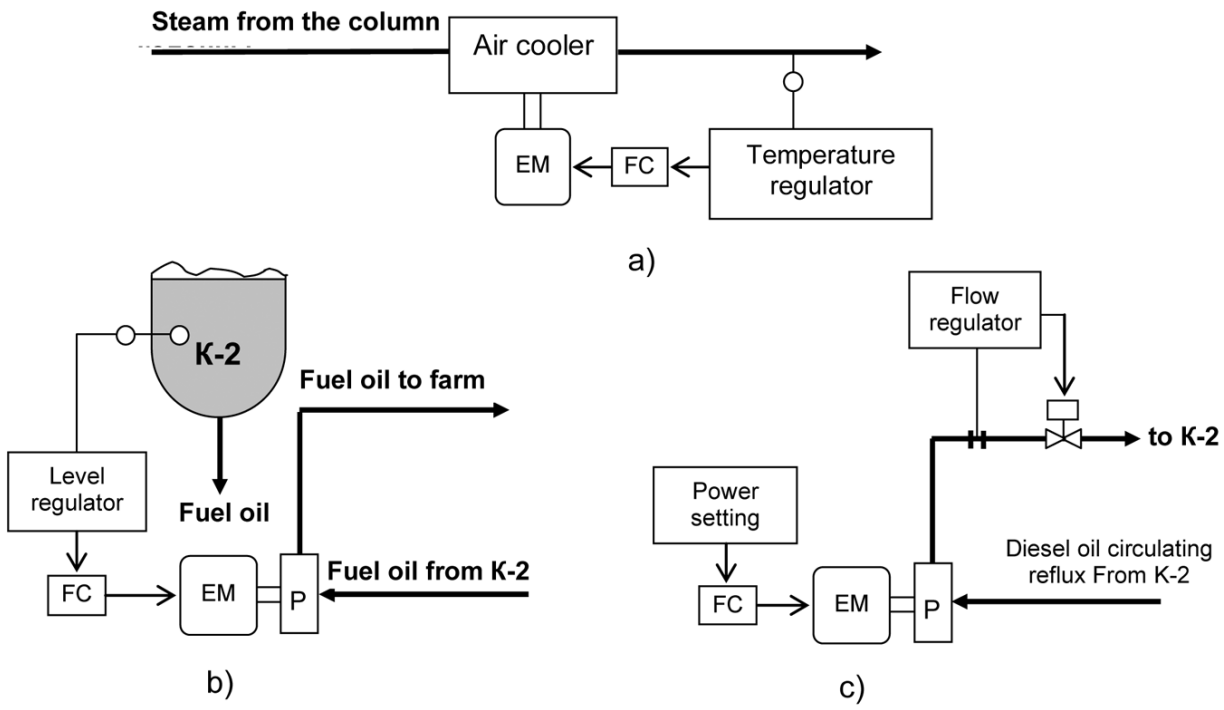
- Air coolers on the output of gasoline vapors from the K-1, K-2 columns (Fig. variant a)
- Pumps on fuel oil pumping from the K-2 column (Fig. variant b)
- Pumps to supply the diesel circulating reflux (DCR) in the K-2 column (Fig. variant c).

Control over the frequency converters is performed from the control system via a standard 4-20 mA current signal.

The use of frequency converters for pumps and air coolers ensures the following results:

- Increased process mode stability in the K-1, K-2 columns
- Reduced energy consumption
- Reduced starting current value, because frequency converters provide a smooth motor start mode
- Reduced operating costs, as well as reduced likelihood of an emergency as a result of reducing the burden on electric motors, thereby extending the service life of bearings and other rotating parts
- It became possible to eliminate the control valve from the control circuit.

The subsystem operates on the **APS-2 unit of «RN-Tuapse Refinery» OOO.**



Variants of using frequency converters in control systems
(Legend: FC – frequency converter, EM – electric motor, P – pump)

Tank farm automated process control system

This automation system is designed for operational dispatch monitoring and control of oil product storage and loading/unloading processes, as well as provide the required technological lockouts and ESD.

Automation object

The object of automation is a distributing oil depot, a fuel terminal.
Main process facilities and equipment: drain railway overpass, open pumping station, tank farm, fill motor overpass, process piping, drainage tanks, leakage collection and pumping tanks, electrically driven shut-off and control valves, firefighting equipment, water treatment facilities.

Implementation objectives

- Unconditional maintenance of the necessary level of safety and reliability of the tank farm during in modes of operation in accordance with regulations
- Reducing the complexity of process operations at the controlled facility
- Improving environmental safety
- Providing the most comfortable working conditions for operating personnel and, as a consequence, minimizing the subjective component of the process.

System functions

Information functions provide the formation of screen images and output forms of information and computing tasks at the request of the operator or non-operational personnel (system administrator), and include:

- Collection and processing of information on the state of process parameters
- Detection, indication and registration of emergencies
- Access control for the main tank farm premises
- Maintaining event log
- Archiving the history of parameters changes to a hard disk
- Generation and provision of operational and archive data to the staff.

Control functions

- ESD and lockouts
- Remote control of shut-off and control valves
- Remote control of pump units
- Management of the oil product drain/fill process: automatic opening/closing of the valves in order to provide the required drain/fill route.

Secondary functions

- Diagnostics of control equipment software and hardware
- Validation of data signals
- System reconfiguration (reconfiguration and parametric software configuration)
- Manual input (changing settings, data control processing constants).

Typical architecture

AThe DCS is built in a hierarchical manner and has a three-tier structure.

At the **lower level** are the system's «field» instrumentation and automation equipment, as well as cable lines.

The **middle level** is based on a microprocessor controller with the required number of I/O modules (digital/analog signals), intrinsic safety barriers and fieldbus communication equipment.

Controllers exchange data with the operator workstation, which makes up the **top level** and is implemented on an industrial touch screen PC.

Software and hardware

Middle level

- Microprocessor controller with I/O modules
- Integrated development environment designed for controller configuration and creation of process programs.

Top level

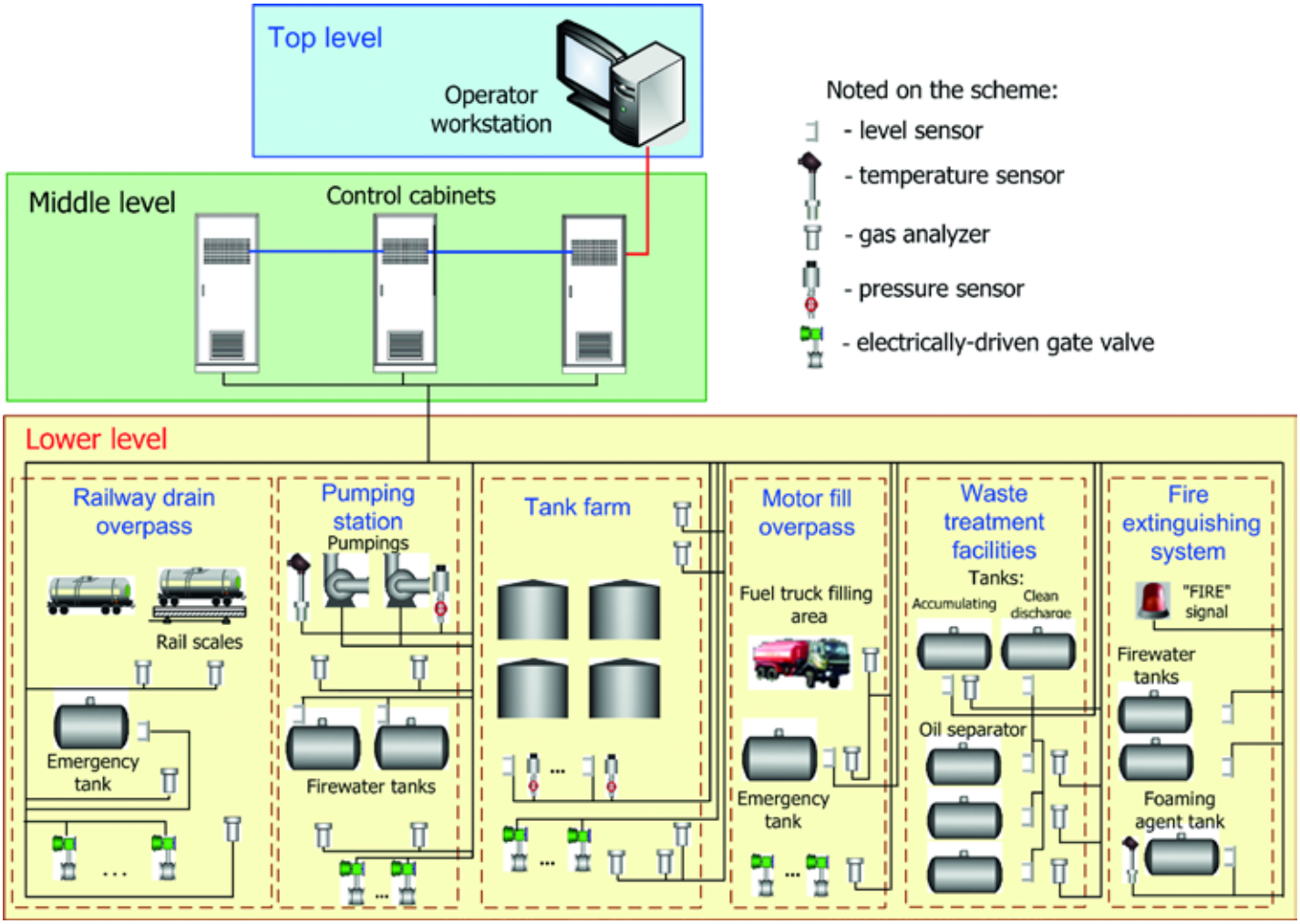
- SCADA system designed to visualize and control the process, maintain an event log, maintain trends, archiving, etc.

Advantages of implementing the system

- Reduction of the operation and equipment maintenance costs of the tank farm
- Protection of equipment and the environment
- Increased operational reliability of the tank farm process equipment
- Providing access control for the main tank farm premises
- Expansion options: connecting additional sensors and actuators to the controller, increasing the number of workstations, etc.

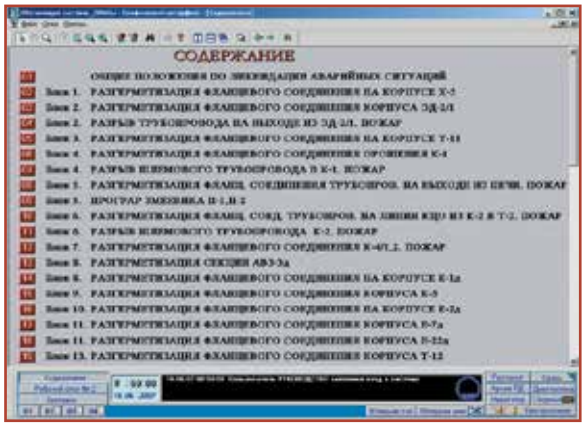
The solution is implemented at the following sites:

- **«NK» Rosneft» OAO tank farm - «Kubannefteprodukt», Tikhoretsk**
- **«BTOF-TERMINAL» OOO marine service center oil storage, Novorossiysk**
- **Fuel terminal, Sukhum etc.**



Computer simulators for personnel emergency response training for chemical and refining industries

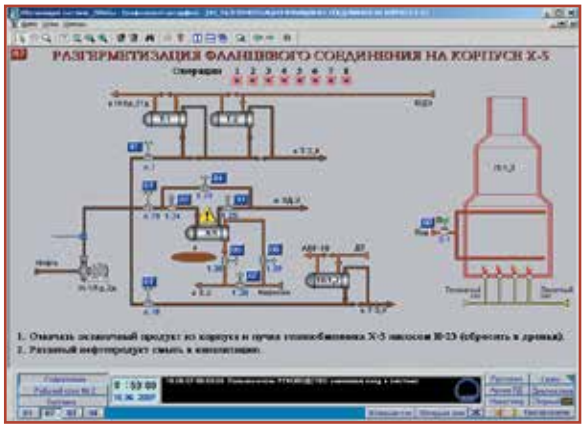
The training system is a PC-based software system. It includes a list of emergencies in accordance with the «Emergency Response Plan» document for the process plant, and modeling of localization and liquidation actions for a particular emergency.



Objectives of the training system

- Education and acquiring practical operational skills for the prevention, localization and liquidation of emergency situations
- Continuous and periodic monitoring and testing of emergency response knowledge and skills
- Improving the quality of training for employees engaged in the process and operation of equipment
- Reducing the likelihood of an emergency due the human factor.

Each emergency situation corresponds to a particular video frame. The video frame is a part of a process scheme with a functional scheme of object automation. The simulator models real process control tools, ensuring identity to the automated operator workstation. All actions performed by the operator are recorded in a database, indicating his name and date of the knowledge test.



KRUG has developed and implemented emergency response training simulators for the following:

- **Crude oil distillation plants AT-1, AT-2 for «NK» Rosneft» - Tuapse Oil Refinery»**
- **Catalytic reforming plant L-35/11-300 for OAO «NK» Rosneft» - Tuapse Oil Refinery»**
- **Crude oil distillation plant AT-2, APS CDU for «Krasnodarekoneft» - Krasnodar Refinery» ZAO.**
- **Crude oil distillation plant APS CDU for «Novoshakhtinsk Oil Refinery» OAO.**

Lease automatic custody transfer (LACT)

Control objects

Systems designed to measure the quantitative and qualitative characteristics of oil and oil products.

DCS implementation objectives

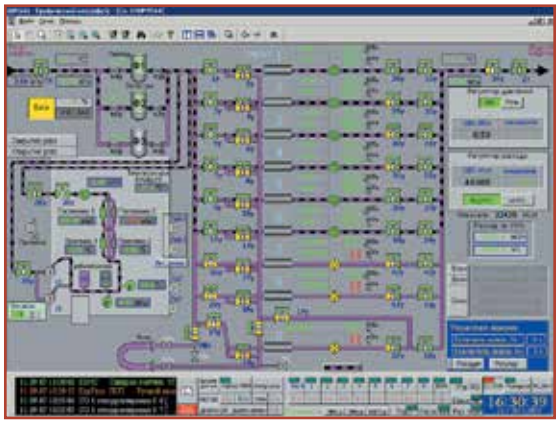
- Ensuring oil custody transfer metering
- Improving the accuracy of process parameter measurement
- Reduction of operating costs
- Ensuring long-term trouble-free unit operation
- Organizing information flow to the supervisory control and data acquisition service
- Improving the quality and reducing the complexity of the work of operating personnel.

System functions

- Measurement of the number of pulses from turbine flow meters and conversion to volume flow
- Measurement of the pulse period from density meters and conversion to density in QCU
- Measurement of the temperature and pressure in the pipelines
- Calculation of the mass flow in the pipelines
- Implementation of valve software and logic control
- Automatic sampling
- Automatic control of pressure differential on filters
- Detection, indication and recording of parameters deviations from established boundaries
- Validation by limit values, rate of change and other criteria
- Reception of status signals and actuators control
- Implementation of emergency shutdown and equipment lockouts, including the main ones:
  - Automatic LACT closing in case of emergency
  - Automatic QCU closing in case of emergency
  - Automatic fire extinguishing
  - Automatic switch to backup equipment in case of failure of the main unit, etc.
- QCU building life support management
- Conduct verification and monitoring of the metrological characteristics of flow meters
- Indication of parameters in digital and table form on mimic diagrams, as well as in the form of graphs
- Indication and sound signalization of parameters crossing set limits, emergency alarm
- Indication of pump, valve, motor valve status with the ability to control them
- Manual data entry (quality certificate, parameter settings, etc.)
- Differentiation of access to controls via passwords
- System time correction
- Generation and printing of message protocols, operator's logs, reporting documents, quality certificates and oil delivery-acceptance certificates
- Viewing archives of paper documents
- Sending data to supervisory control
- Self-diagnostic of system equipment.

Software

- KRUG-2000® SCADA, including development (database generator, graphical editor, process programming language, etc.) and runtime environments (operator workstation executable modules)
- The controller real-time operating system (RTOS), allowing to create hot standby schemes: 100% redundant controllers, redundant controller processor parts.



Components

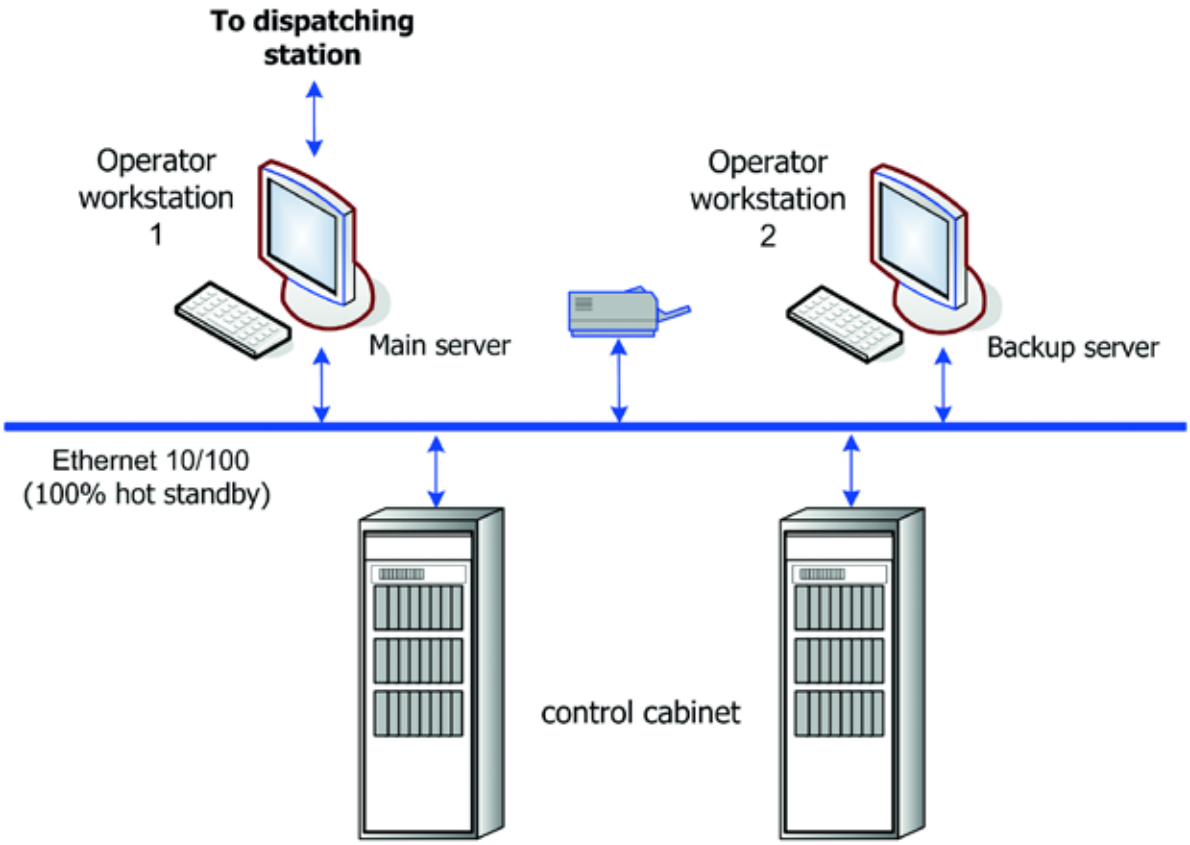
- LACT composition, the technical and metrological characteristics of its measuring instruments and equipment meet the requirements of regulatory documents: «Guidelines for the design of commercial oil metering units» and RD 153-39.4-042-99.
- LACT is a two-tier distributed system with a multi-tier failure protection, ensuring high reliability.
- The lower level consists of modern, highly reliable microprocessor-based controllers. The controllers are made with 100% hot standby. The controllers are enclosed in cabinets located in the operator room.
- The upper level consists of operator workstations based on two database servers with a 100% hot standby function, combined with the operator workstation.
- Communication with the lower-level controllers is performed via an Ethernet LAN (100% redundancy).

Conclusions

Experience in operating custody transfer metering systems has confirmed the possibility of using KRUG-2000® SCADA for implementing the biggest challenges associated with commercial oil metering.

This solution is implemented on the following sites:

- **Crude fiscal metering station No. 13, Omsk**
- **Crude fiscal metering station No. 702, Adamovo, Poland**
- **Crude fiscal metering station No. 201 «Kalchinskoye field», Tyumen**
- **Stable condensate (oil) fiscal metering station No. 1100 «Surgut ZSK», Surgut**
- **Crude fiscal metering station «Permyakovskoe field», Nizhnevartovsk**
- **Crude fiscal metering station «Koshilskoe field», Nizhnevartovsk**
- **LACT station No. 544 «North fields», Nizhnevartovsk**
- **LACT station No. 578 «Samotlor field», Nizhnevartovsk**
- **Crude fiscal metering station No. 364E «Belkamneft», Neftekamsk.**



Integrated energy metering system

Control objects

Sulphur recovery unit, AVPS-6 CDU, bitumen production unit, South heating plant, North heating plant, chemical water treatment plant, steam reduction unit, nitrogen reduction units, natural gas metering unit.

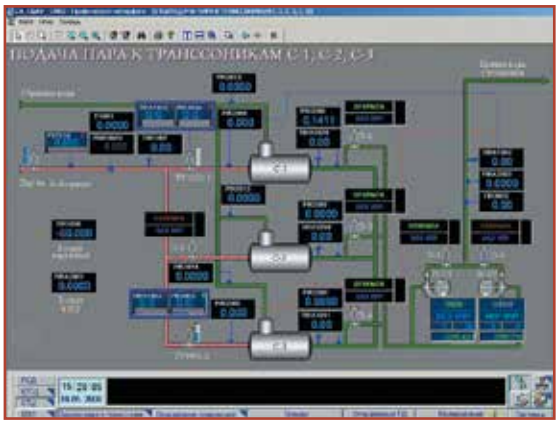
DCS implementation objectives

- Increase the enterprise production efficiency as a result of increasing accuracy and reducing the complexity of consumed energy metering, reducing energy losses by identifying bottlenecks in its distribution and consumption in terms of detection of non-normative costs and losses
- Harmonize mutual financial settlements with suppliers and consumers of energy resources by means of their custody transfer metering
- Improve the reliability and quality of gas, heat and water supply of the whole enterprise through optimal control of process equipment operation modes in accordance with technological regulations, as well as timely detection and prevention of further development of emergencies.

System functions

Information functions

- Operational monitoring of the actual energy consumption of individual technological objects and enterprise-wide
- Custody transfer and technical metering of the energy resources of the enterprise
- Rapid balancing of enterprise energy resource accounts, identification of bottlenecks in terms of excessive costs and losses
- Centralized collection and archiving of the system's process data
- Prompt (real-time) process information provided to operational staff, management and the company leadership.



Control functions

- Automatic control of the technological parameters of the enterprise gas, heat and water supply system
- Implementation of technological protections and lockouts of the enterprise gas, heat and water supply system process equipment
- Centralized dispatch control of the enterprise gas, heat and water supply system process equipment.

Secondary functions

- Maintaining unified system time for system users.

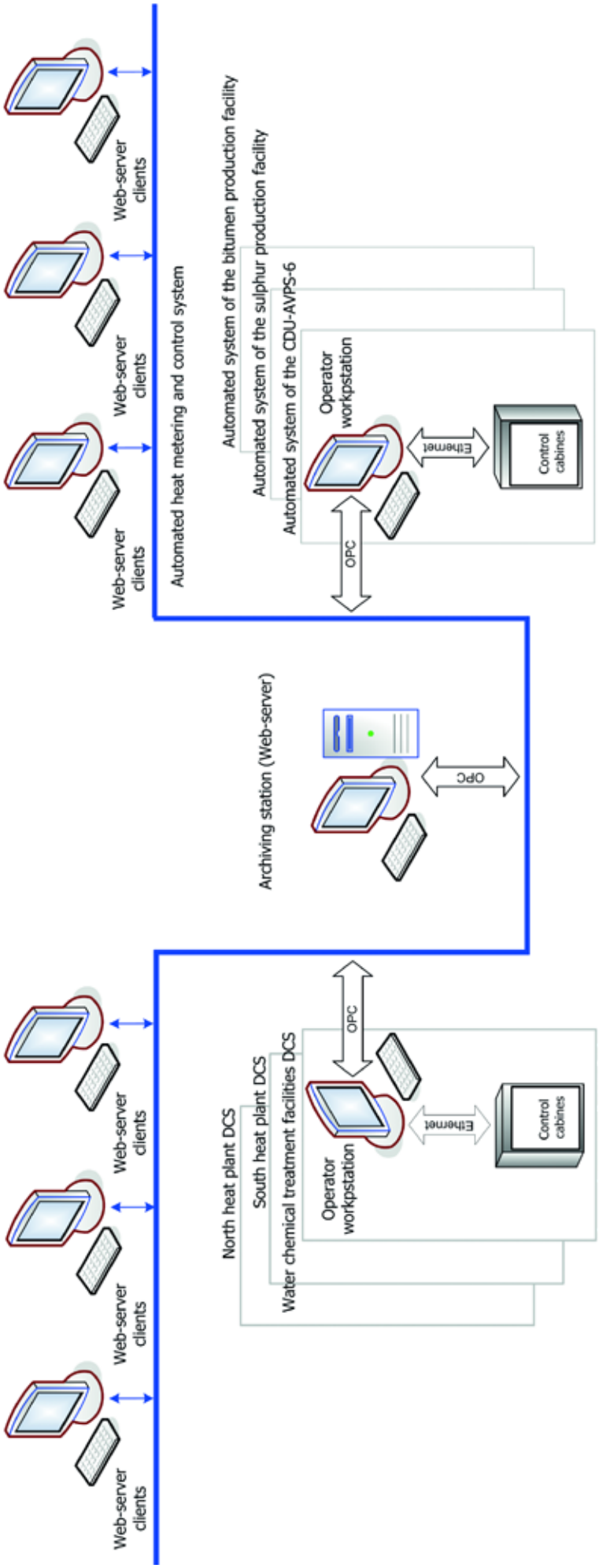
System components

Local operational database servers, centralized data collection and storage server (archiving station), operator (dispatching) and non-operational staff automated workstations.

Implementation results

- Ensuring metering of all types of enterprise energy resources on the basis of a uniform set of software and hardware
- Improving the accuracy and reducing the labor intensity of metering consumed energy resources
- Obtaining a realistic picture of the actual consumption of energy resources by the enterprise, rapid detection of non-normative costs and losses of energy resources in their distribution and consumption
- Energy supplier settlements based on reliable and objective data
- Ensuring the reliability and quality of gas, heat and water supply of the enterprise as a whole.

This solution is implemented at **«Saratov Oil Refinery» OAO.**


Web-server clients
Web-server clients
Web-server clients
Automated heat metering and control system
Automated system of the bitumen production facility
Automated system of the sulphur production facility
Automated system of the CDU-AVPS-6
Operator workpstation
Ethernet
Control cabines
OPC
Archiving station (Web-server)
OPC
Web-server clients
Web-server clients
Web-server clients
North heat plant DCS
South heat plant DCS
Water chemical treatment facilities DCS
Operator workpstation
Ethernet
Control cabines
OPC

Customers

«NK» ROSNEFT» - «STAVROPOLNEFTEGAZ» OAO	PO «KIRISHINEFTEORGSINTEZ» OOO «SURGUTNEFTEGAS» OAO
«NK» ROSNEFT» - TUAPSE OIL REFINERY» OAO	«TATNEFT» OAO»
«NK» ROSNEFT» - KUBANNEFTEPRDUKT» OAO»	«AZNAKAEVSKNEFT»
«SLAVNEFT» - YAROSLAVL MENDELEEV OIL REFINERY» OAO	«TNK - Nizhnevartovsk» OAO»
«NOVOKUIBYSHEVSK OILS AND ADDITIVES PLANT» OOO	«Saratov Oil Refinery» OAO TNK BP
«BelkamNeft» OAO	«KRASNODAREKONEFT» - KRASNODAR REFINERY» ZAO
«PAVLODAR OIL REFINERY» ZAO	DSG «KAVKAZTRANSGAZ» OOO»
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